Sources and Fate of Terrigenous Organic Matter in Modern and Ancient Sediments from the Northern Gulf of Mexico

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Coastal marine sediments are the predominant long-term sink for organic matter (OM) in the ocean. The delineation between OM sources deposited in marine sediments, particularly between land and ocean contributions, is essential for the quantitative understanding of the global carbon cycle. The goal of this research is to trace land-derived carbon in modern and ancient sediments of the Gulf of Mexico (GMex). The specific research objectives are to examine the sources and fate of terrigenous OM (OM_{terr}) in coastal sediments, to quantify OM_{terr} in modern and ancient sediments, and to evaluate long-term, climatically induced changes in North America's vegetation.

Marine geochemists have traditionally assumed OM_{terr} to be compositionally homogenous. Such an assumption has led to an underestimate of terrigenous contributions to sedimentary OM. The results from this research indicate that OM_{terr} is in fact heterogeneous, composed of at least two chemically distinct endmembers (vascular plant matter and soil-derived OM). Results of a three-endmember mixing calculation, which is utilized to account for this heterogeneous composition, indicate that OM_{terr} accounts for approximately 65-80% of the OM deposited as shelf sediments. Importantly, the abundance of OM_{terr} is 40-85% higher using this approach than indicated by the traditional two-endmember mixing approach. Such a calculation demonstrates how OM_{terr} has been previously underestimated, and highlights the need for its requantification given the contribution from two distinct components.

The overall goal of this research is to distinguish between C3 (cool growing temperature) and C4 (warm growing temperature) sources of terrigenous vegetation in the modern and ancient marine sedimentary record. Preliminary results from modern sediments indicate that C3-derived terrigenous vegetation is preferentially deposited close to shore. C4-derived OM, which accounts for less than 50% of OM_{terr} deposited in these sediments, appears to be preferentially transported offshore.

The final stage of this research is focused on determining the relative abundance of C3 and C4 terrigenous carbon in ancient sediments (1,000 to 100,000 years) of the GMex in order to ascertain the effect of climate change on North America's vegetation. Bulk isotopic and molecular measurements from a long-term (~7000y) sedimentary record suggest an expansion of C4 vegetation in North America during the late-Holocene. Preliminary data from this core further indicate such a vegetation shift. The measurements currently underway will be used to evaluate vegetation shifts in the early Holocene and late-Pleistocene (ca. 100,000y) sediments from the Gulf of Mexico.